Mass redistributions in West Africa induced by the monsoon system: comparison of GPS, GRACE and geophysical models

Samuel Nahmani (1), Olivier Bock (1), Marie-Noëlle Bouin (2), Alvaro Santamaría-Gómez (3), Guy Wöppelmann (4), Xavier Collilieux (1), Jean-Paul Boy (5), Caroline de Linage (6), Jacques Chedhomme (7), Tonie M. van Dam (8)

(1) LAREG, Institut Géographique National, Marne La Vallée, France; (2) Centre de Météorologie Marine, CNRM, Brest, France; (3) Instituto Geográfico Nacional, Madrid, Spain; (4) LIENSS, Université de La Rochelle, La Rochelle, France; (5) EOST-IPGS (UMR 7516 CNRS-UdS), Strasbourg, France; (6) Earth System Department, University of California, Irvine, USA ; (7) ENSG, Institut Géographique National, Marne La Vallée, France; (8) Faculté des Sciences, de la Technologie et de la Communication, University of Luxembourg, Luxembourg;

Mass redistributions in West Africa induced by the monsoon system generate seasonal variations in the gravity field and produce deformations of the Earth. Since 2005, a network of ground-based GPS receivers has been established over West Africa as part of the instrumental setup of the African Monsoon Multidisciplinary Analysis (AMMA) and is now also contributing to the Gravity and HYdrology in Africa (GHYRAF) project. The GPS data were processed as part of the TIGA GPS analysis at the ULR Consortium (Université de La Rochelle and IGN/LAREG) to obtain coordinates within a well defined reference frame.

GPS station position residuals are compared with the sum of hydrological (GLDAS/Noah), atmospheric (ECMWF) and oceanic (MOG-2D) loading simulations and also with GRACE (CNES/GRGS-RL02) loading estimates. The regional-scale water mass variations generate the main part of the deformations at Sudanian and Guinean stations but the Heat Low atmospheric pressure variations are the dominant source of deformations at the Saharan stations. Differences between the three datasets are discussed. The GPS height variations confirm that Earth response to mass redistribution is mainly elastic (correlations between GPS and simulations or GRACE are as large as 75%) but we detect an additional signal whose peak-to-peak amplitude can reach 12 mm. Examination of error sources in GPS data processing suggests that the origin of this signal is rather geophysical. It might be related to

more local hydrologic effects such as vertical and lateral water flow in the aquifer and exchanges with rivers, ponds or water storage basins.